Technical Specification for work of Providing & Laying 1200mm RCC NP3 Nandini Layout Trunk Sewer Pipeline from 9th Main road to 35th Main, Jai Maruti Nagar further linking to Mailasandra STP.

I) General:

1.1 Equivalency of Standards and Codes

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be procured, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be acceptable subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the documents.

1.2. Sign Board

The Contractor shall provide a sign board at the site of the Works of approved size and design which provides (i) the name of the Project (ii) the names and addresses of the Employer, the Contractor and the Consultant; (iii) the name and short description of the Project, (iv) the amount of the Contract Price ; and (v) the starting and completion dates.

1.3. Samples and Tests

The Contractor shall be responsible to develop a quality control program and to provide all necessary materials, apparatus, instruments, equipment, facilities and qualified staff for sampling, testing and quality control of the materials and the works under the Contract. Without limiting the generality of the foregoing, the Contractor shall either (i) establish a testing laboratory at the site of Works which is adequately equipped and staffed to carry out all sampling and testing in accordance with the requirement set out in the General Specifications and/or these Special Specifications and provide all field equipment and apparatus as necessary to conduct all specified in-situ tests and/or any Tests on Completion, provided the correctness of the equipments are ensured or (ii) arrange for routine sampling, testing and reporting, as required, through a certified independent testing laboratory acceptable to the Engineer. All costs of such sampling, testing and reporting of test results will be borne by the Contractor.The Contractor shall furnish certified copies of all test reports to the Engineer within 3 days of completion of the specified tests.

The Contractor shall make necessary arrangements for conducting the quality control programme during execution of the Works, including details of his testing laboratory, equipment, staff and general procedures. If following submission, or at any time during the progress of Works, it appears to the Engineer that the Contractor's quality control programme is not adequate to ensure the satisfactory quality control.

1.4. Protection of Utilities

The Contractor is required to carefully examine the location of the Works and their alignments and to make special enquiries with all authorities concerning all utility lines such as water, sewers, gas pipe, telephone (underground and/or overhead) lines, electric cable (underground and/or overhead) lines, etc.; and to determine and verify to his own satisfaction the character, sizes, position and lengths of such utilities from authentic records. The Contractor shall be wholly responsible for the protection and/or facilitating relocation of such utilities as may be required, and shall not make any claim for extra work or extra time that may be required to protect or facilitate relocating such utilities. If any major shifting or realignment of water, sewers, gas pipes, electric and telephone lines is necessary due to their interference with the proposed Works, the same may be done by the Employer. The cost of such relocation will be borne by the Employer. In case the alignment of the pipeline crosses high tension electrical transmission lines belonging to the Karnataka Power Transmission Corporation Ltd. (KPTCL) or other authorities, the Contractor shall take all precautions necessary to see that the work is carried out with care and safety, without disturbing such transmission lines. The Contractor will be responsible to carry out all construction activities in such reaches in consultation with the owners of such facilities. However, satisfactory completion of the entire work will be the responsibility of the Contractor.

2.0 Detailed Specifications:

The manufacture, supply, laying, jointing testing and commissioning of pipes used for sewage disposal shall generally conform to specifications.

2.1 Manufacture, Supplying, Laying, Jointing and Testing of pipes

Manufacturing, supplying, laying, jointing, testing and commissioning of pipes used for Sewerage shall generally conform to Standard specification. The alignment of sewer lines given in the drawing is only indicative and the exact alignment will be as per construction drawings / as directed by the Engineer or his representative. The alignment of sewers runs along side or centre of or across the carriageway and in some stretches it runs along the storm water drains. In these stretches the top of the Machine holes shall be raised above the high flood level of the drains as per the details given in the construction drawings. Pipes shall be laid underground with a minimum earth cover of 1m above the crown of the pipe, unless otherwise specified. All pipes, fittings and material shall be inspected and approved by the Engineer before being laid. Any pipes, fittings or material placed before they are inspected and approved shall be removed and replaced with approved material. Before laying the pipe, necessary bedding shall be provided to the pipes, wherever specified.

In general, unless and otherwise specified, the sewer lines shall be of RCC NP-3. The branch sewer crossing the storm water drains and roads (limited to span of crossing only) in the project town, as indicated in the drawing, shall be of RCC pipe.

Contractor has to conduct hydraulic test of sewer lines from Machine hole to Machine hole throughout the length upto disposal point. The hydraulic test are from Machine hole or from sewer to the end of the pipeline laid up to property or the length as directed by the Engineer.

2.1.1 Reinforced Cement Concrete Pipes

Manufacture of pipe

The RCC pipes to be used for lateral, branch and trunk / outfall sewers shall be of class NP-3 & NP-4, Spigot and Socket (S&S) type, with rubber gasket jointing, manufactured in Conformity with IS 458. All the Pipes shall be manufactured using **Sulphate resistant cement** and Marked with ISI. The ends of the pipes shall conform to Clause 5.3 of IS 458 as applicable for S&S joints. The rubber ring shall conform to IS 5382 and IS 12820 as applicable for sewer lines and shall be of type 'IA'. The diameters of pipes shall be as required for sewers as per designs and drawings.

The method of manufacture shall be such that the form and dimensions of the finished pipes are accurate within the limits specified in relevant IS: 458. Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

The Internal diameter, wall thickness, length of barrel, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement, strength test requirements, tolerances on - overall length, internal diameter or dimensions of sockets / spigots of pipes shall be as per the relevant clauses / tables of IS: 458. Minimum clear cover to reinforcement shall be 15 mm. The tolerances regarding overall length, internal diameter of pipes or socket and barrel wall thickness shall be as per relevant clauses of IS: 458. Each pipe unit can be in lengths of 2 m to 4 m based on availability, ease in handling, transportation and laying.

The workmanship and finish for the pipe will conform to the relevant standard specification at section-9. Cleaning of pipes shall conform to relevant Standard specification.

Jointing of pipes with Spigot and socket joints shall conform to the relevant Sub Clauses

2.1.2 Testing of pipes during manufacture

During manufacture, tests on concrete shall be carried out as per IS: 456.

The specimen of pipes for the following tests shall be selected in accordance with Sub-Clause 9.1 of IS: 458 and tested in accordance with the methods described in IS: 3597:

1. Hydrostatic testing
2. Three edge bearing test
3. Absorption test

2.1.3 Laying of the pipe

Laying of concrete pipes shall conform to the Code of practice of IS: 783. Pipes shall be laid underground with a minimum earth cover of 1m. Pipes shall be generally laid in sections of 300 m each. Laying of pipes shall be as per Clause stated above for Procurement of Project Works. All pipes, fittings and material shall be tested and approved by the Engineer before being laid. Any pipes, fittings or material placed before they are tested and approved shall be removed and replaced with tested and approved material. Before laying the pipe, necessary bedding shall be provided wherever required as per Sub-Clauses 6.4.1, 6.4.2, 6.4.3 and 6.4.4 of this section.

2.1.4 Jointing of pipes

The pipe joints shall be flexible joints, jointed by rubber ring of type 'IA', as per IS 783-1985. The sections of the pipe shall be jointed in such a manner that there shall be as little unevenness as possible along the inside of pipe. Care should be taken while jointing to provide the correct gap between the end of spigot and back of the socket to ensure flexibility at each joint and correct location. The joints shall be finished as directed by the Engineer. The quality of rubber ring, tolerances, etc., shall be in conformity with IS 5382-1985.

2.1.5 Measurement of pipes

The length of the sewer pipes shall be measured between the inner surfaces of consecutive Machine holes at the invert level of the pipes along the central line of pipeline to the nearest centimeter.

3.0 Machine holes

Machine holes shall be constructed at places as shown in the drawings or as directed by Engineer for which payment shall be made at quoted rates. Any Machine holes required to be provided extra, at the locations shown by the Engineer, shall be provided by the Contractor, for which payment shall be made extra at the quoted rates. The Contractor is responsible for giving suitable connections at the junctions of sewer lines with the Machine holes. The Machine holes have been divided into different categories based on depth. The depth of Machine hole shall be measured from the top of cover to the invert level of the deepest outgoing sewer from the Machine hole.

3.1 RCC Machine holes

The construction of **RCC Machine hole chambers (Cast-In-Situ or Pre-Cast)** includes,

Earth work Excavation in all classification of soils including hard rock by blasting / controlled blasting/ chistelling as directed including cutting road surface of all types and depositing of the excavated stuff on Bank upto a lead of 30mts with danger lighting and use of sight rails and boning rods wherever necessary, shoring and Strutting wherever required including excavation in watery situation or foul conditions where the over night recuperation does exceed 1m.

Providing and Construction of RCC Machine hole chambers 1:1.5:3 of approved type Cast -in situ/Pre-cast RCC Machine hole chambers, constructed using form vibrators of standard type, with barricading, danger lighting and use of sight rails and boning rods wherever necessary, shoring and strutting wherever required using Sulphate Resistant cement of 1:1.5 :3 proportion RCC, with 20mm and down graded jelly, well graded sand and steel approved quality, 200mm thick top concrete slab, having wall thickness and raft thickness as in approved drawings and with an offset in raft round the chamber as in approved drawing, benching concrete with 1:6 slope towards the central drain finished smooth, including fixing and grouting of pipes, including supply conveying to work spot, and fixing SFRC Machine hole cover and frame (Heavy Duty) confirming to IS 1726 with latest amendments , on a bed of CC1:2:4 supplying

and fixing of minimum 3mm thick encapsulated plastic foot steps (as per IS : 10910) on 12mm dia. Grade FE 500 steel bar (as per IS : 1786) staggered at 300mm apart as detailed in technical specifications, including sand bedding where ever required, disposal of surplus earth, watering, curing, engraving Machine hole number with flow direction on the inner cylindrical surface etc., complete including cost of reinforcement steel and fabrication charges and also cost and conveyance of all materials, labour / DI R/C with all leads and lifts for various diameter and depths noted below as per specification, drawing and as directed by Engineer inclusive of Earth work excavation in type of soil.,

Supply and fixing Machine hole frame and cover (SFRC of heavy duty cover as directed) in 1:2:4 CC, watering, curing, barricading, pouring tar over MH frame and cover, cost of tar, dewatering, engraving Machine hole number on the inner surfaces etc., as per drawing with all lead and lifts

Refilling in trench with selected available earth obtained from chamber excavation including watering and consolidation in layers 150mm thick and disposing of the surplus earth as directed for various diameters and depths.

Machine holes shall be constructed at places as shown in the drawings or as directed by Engineer for which payment shall be made at quoted rates. Any Machine holes required to be provided extra, at the locations shown by the Engineer, shall be provided by the Contractor, for which payment shall be made extra at the quoted rates. The Contractor is responsible for giving suitable connections at the junctions of sewer lines with the Machine holes.

4.0 TESTING

WATER FOR WORKS

The contractor should make his own arrangements for procurement and conveyance of water for construction, testing and other purposes in connection with the works.

5.0 Laying of pipe

Pipes shall be laid underground with a minimum earth cover of 1M. All pipes, fittings and materials shall be tested and approved by the Engineer before being laid. Any pipes, fittings or material placed before they are tested and approved shall be removed and replaced with tested and approved material.

6.0 Other Specials and Instruments

The Contractor is responsible to provide sufficient number of specials, as required for completing the work satisfactorily. The exact number of specials specified in Bill of Quantities, may increase or decrease depending on the requirement.

7.0 Commissioning

After satisfactory testing of the entire length of main, lining and coating of pipes, connections to the inlet and outlets, and successful construction and testing of the Master Balancing Reservoirs, the works shall be commissioned for operation.

II) EARTH WORK:

1. GENERAL:

The earth work excavation for laying of pipe shall be carried out. The Contractor shall make all excavations required for laying and jointing of the pipeline and construction of pertinent structures as required in the project. Except where otherwise required by the project or instructed by the Engineer, all excavation shall be in open cut to the specified widths and depths. The Contractor is advised to satisfy himself with regard to the likely conditions that may be met with during the execution of the Works, with regard to the underground obstructions or conditions, necessary dewatering requirements etc. Before commencing the earth work, the Contractor shall carry out detailed survey of the proposed alignment, prepare construction drawings showing the longitudinal section of the ground profile, locations of valves and other appurtenances and submit to the Employer for approval.

2. CLASSIFICATION OF EXCAVATION

All materials involved in excavation shall be classified in three categories as follows:

2.1 Ordinary soil

This includes excavation in all types of soil including soil containing gravels, murums, loose boulders, viz., ordinary gravely soil, hard gravely soil, wet soil, stiff slushy soil, chettu soil and calcareous strata, but exclusive of disintegrated rock, soft rock/shale;

2.2 Soil Containing Disintegrated Rock, Soft Rock and Soft Shale

This category includes excavation in soil containing disintegrated rock, soft rock or soft shale which can be cut by shovel and no hand or mechanical chiseling is required.

2.3 Medium Hard Rock

This category includes excavation in lime stone, sand stone, hard shale and schist fissured rock, without resorting to blasting.

2.4 Hard Rock

This category includes excavation in hard rock requiring hand or mechanical chiseling or blasting. In case of difference in opinion between the classification of rock requiring blasting and that requiring chiseling, wedging, the site of work shall be inspected by the engineer and the decision of the Engineer shall be final and binding on the Contractor.

3 Limits of excavation

The trench for laying RCC pipes of all sizes shall have minimum width as per standards stipulated or as directed by the Engineer-in-charge A minimum earth cover of 1.0 m shall be maintained above the pipe top, unless otherwise specified or shown in the alignment drawings. Any extra excavation required for providing suitable bedding for the pipeline or for maintaining the grade of the pipeline, shall be paid extra at actual, and based on the quoted rates.

The Contractor shall be responsible to ensure that the widths and depths of the trenches do not exceed the limits shown in the construction drawings. Should the excavation occur beyond the dimensions specified therein, because of the negligence of the Contractor, the Contractor shall fill the excess space with granular material or concrete as directed by the Engineer. Nothing extra shall be paid to the Contractor on account of this.

4 Slips and slides

The Contractor is responsible for proper protection of excavations made by him from any slips and slides. All slides and caving shall be handled, removed or corrected by the Contractor without any extra compensation at whatever time and under whatever circumstances they may occur. The excavations shall be made good and brought to necessary depth, width and levels without any extra cost.

5. Stacking of excavated material

The excavated material shall be stacked at least 600 mm away from the sides of the trench.

6. Safety measures

The Contractor shall provide adequate safety measures during excavation. They shall include:

1. Barricading all sides of the open trenches
2. Red danger lights which can be easily visible from dusk to dawn placed at an interval of 20 m and at all the road crossings.
3. Traffic signals and display boards giving direction for diversion of traffic at the appropriate places as may be directed by the Engineer.
4. Adequate safe wooden plank / board or steel plate over the trenches at every 15 meters interval to facilitate crossing by the public residing on either side of the trench.
5. Round the clock watch and ward maintaining all safety regulations at the site of work and protecting the site from unauthorised intrusions.

7. Progress of Excavation of pipe trenches

The Contractor shall adjust excavation of trenches in such lengths that the pipes can be laid in such exposed portion of the trench within 2 days.

8. Shoring and Bracing

The Contractor shall supply, fix and maintain necessary sheathing, shoring and bracing etc., in steel or wood, as may be required to support the sides of the excavation, to protect workmen in the trench and to prevent any trench movement which might any way injure or delay the work, change the required width of the trench, make unsafe condition for adjacent pavements, utilities, buildings or other structures above or below ground.

Sheathing, shoring and bracing shall be withdrawn and removed as the backfilling is being done, except when the Engineer may agree that such sheathing, shoring and bracing be left in place, at the Contractor’s request. In any case, the Contractor shall cut off any such sheathing at least 600 mm below the surface and shall remove the cut off material from the trench.

All sheathing, shoring and bracing which are left in place under the foregoing provisions shall be removed in a manner so as to not endanger the completed work or other structures, utilities or property, whether public or private.

9. EXCAVATION

9.1 Excavation in Rock

Excavation in rock shall be carried out to a depth, 150 mm more than the bottom level of pipe and to a width equal to the diameter of the pipe plus minimum working space on either side as given in drawing. Unless otherwise directed by the Engineer, rock excavation shall be progressed at least by 50 m in advance of the pipe length proposed to be laid.

9.2 Excavation for Inlets, Junction Chambers and Other Appurtenant Structures

The Contractor shall excavate as required for all structures with foundations to firm, undisturbed earth up to the level of the under side of the structure. If the excavation is in rock, the Contractor shall excavate all rock at least to the minimum limits shown on the standard details for trenches and to the grade of the bottom of inlets, junction chambers or other structures as required. Where the bottom of the structure is in rock, it should be ensured that no rock shall project above the lower surface of the concrete in such a manner so as to reduce the required thickness of concrete placed simultaneously as an integral part of the foundation and to the outside of structure foundation where structure is to be built. The Contractor shall excavate the trench / pit to provide necessary working space on all sides and for accommodating any sheathing, shoring or bracing etc.

10. Contractor's Responsibility

The Contractor shall be responsible for the adequate pumping, drainage and bailing out water from the excavated trench. In case of failure to make such provisions or any other provisions which may result in unsuitable sub-grade conditions, the Contractor shall replace and repair the sub-grade as directed to the satisfaction of the Engineer, at his own cost and responsibility.

Should the Contractor select to use a gravel sub-grade to facilitate flow of water to pumps or other points of disposal, such gravel sub-grade shall not be measured or paid for as an extra item.

11. Works Included in Excavation

The following works as per specifications are also included in excavation and the term 'Excavation' shall construe to mean all such items of work. The quoted rates should include the same:

1. Provision of side space or additional space in the trench/pit for working and/or accommodating sheathing, shoring, bracing, etc.
2. Supply, installation and removal after the work, all sheathing, shoring and bracing required to protect the excavation where required or where such work is recommended by the Engineer.
3. Protection of excavations.
4. Providing adequate safety measures.
5. Additional work in connection with overhead wires and poles.
6. Excavation for Socket hallows.
7. Change of trench location in accordance with Clause 15.7.7 of Chapter 10.
8. Supplying and fixing of sight rails and boning rods in the trench to facilitate measurement of work.

12. Measurement and Payment for Excavation

12.1 FOR EXCAVATION

The measurement for excavation shall be considering the allowable widths, depths with allowed side slopes (if any) for different classes of soils as per approved classification. The measurement for excavation shall be based on “neat line” dimensions as specified in the drawing or Specifications, for different types of soils and depth of excavation. The total volume of excavation shall be computed as a square bottomed trench of width equal to the outer diameter of the pipe, with minimum working space as given in the drawing, added to it, length up to the length of the trench being measured. The depth of trench being average depth taken at 30 m intervals, between the level of bottom of trench and the original surface of the ground. The length of the trench shall be measured as per the actual length of pipes and fittings / specials laid at work site. However depth shall be measured at closure intervals at vulnerable places. The volume of excavation for structures like valve chambers, thrust blocks and anchor blocks etc., shall be computed and measured for payment as per the bottom area of the particular structure on outer periphery multiplied by the average depth between the level of the finished bottom of the structure and the original surface of the ground. The quantity shall be measured in cubic meters correct to two decimal places. The method of measurement for excavation in different classes of soils shall be as follows:

12.2 IN ORDINARY SOIL AND SOIL MIXED WITH DISINTEGRATED ROCK AND SOFT ROCK / SHALE

In this category of soils, the excavation quantity shall be computed as specified above.

12.3 IN HARD ROCK

In case of hard rock requiring chipping or chiseling, measurements shall be taken prior to and after chiseling and the volume of rock excavation shall be measured based on this difference. In case of excavation in hard rock by blasting, the quantity of rock excavated shall be stacked along the side of the trench, which will be cross checked with the trench dimensions. The excavation in rock shall be paid on stack measurements with a deduction of 40% in volume for voids. However, the payment for rock excavation by blasting shall be limited so as not to exceed the volume computed based on the trench dimensions as per specifications.

12.4 FOR EXCAVATION IN COMBINATION OF ORDINARY SOIL, DISINTEGRATED ROCK, SOFT ROCK/SHALE AND HARD ROCK/SCHIST

Wherever the excavation is undertaken in combination of ordinary soil, disintegrated rock, soft rock /shale and hard rock, the hard rock part shall be measured and paid, the soil part shall be measured and paid for the total measurable excavated quantity deducting the quantity measured for the hard rock. The total computed volume of excavation shall be equal to the sum of the computed volumes for each category of excavation undertaken.

III) BACK FILLING

1. Backfilling of Trenches and around foundations of structures

1. General

The Contractor shall use selected surplus spoils from excavated materials for backfilling. All fill material shall be subject to Engineer's approval. The excavated materials suitable for backfilling shall be stored not closer than 600 mm from the edge of the trench and shall not obstruct any public utilities or interfere with travel by local inhabitants or general public. Handling and storage of excavated materials must meet with the regulations of the Local Government Authorities. The detailed specifications for backfilling shall be as per Clause 8 of IS: 3114-1994 and Clause 4.11 of IS 12288-1987.

2. Method of Backfilling

Trenches and excavated pits for structures shall be backfilled to original ground level or to such other levels, as the Engineer may direct. All backfilling shall be carried out in orderly manner expeditiously and consistent with good workmanship.

Backfill material put into the trenches/pits for backfilling, shall unless otherwise specified be compacted and built up as to minimise future settlement as much as is reasonably possible. For this, care shall be exercised in selecting backfill material free from large hard clay lumps, especially in cramped areas directly adjoining the walls of structures.

Backfilling in trenches shall be done as pipe laying progresses, with the permission of the Engineer, after the pipe or conduit is properly bedded, jointed and inspected and all measurements for the location of Y-Junctions, tees, etc., are properly recorded by the Engineer and sufficient time is allowed for the joint materials or cement concrete or mortar to set. However the joints shall be left open for inspection during testing, which shall be backfilled after successful completion of testing, after obtaining permission from the Engineer. Backfilling around and over the pipe, conduit, or structure shall be taken up uniformly on all sides and in the sequence and manner specified hereinafter, with care to avoid the displacement or damage to the pipe, conduit or structure. For the purpose of backfilling, the depth of trench shall be divided into the following three zones measured from bottom to top of trench, as follows:

i. Zone A : From bottom of trench to the centre line of pipe,

ii. Zone B : From the level of centre line of pipe to a level of 300 mm above the top of pipe,

iii. Zone C :From a level of 300 mm above the top of pipe to the top of trench.

Backfilling in the trenches and around structures shall be carried out in horizontal layers of uniform thickness of not more than 150 mm when measured loose. As may be necessary to attain maximum compaction, the backfill material shall be moistened by sprinkling with water. After placing each layer of backfill material, the layer shall be thoroughly and uniformly compacted by means of mechanical or hand tampers. The compacting equipment and the manner of its use shall be subject to the approval of the Engineer.

After the backfill material is placed in Zone A and Zone B as specified above, the remaining portion i.e., Zone C of the trench may be machine backfilled. Even in this case the backfill material shall be placed in uniform horizontal layers of not more than 150 mm thickness. Small pebbles of size less than 50 mm, if any, shall be so distributed throughout the mass, that all interstices are solidly filled with fine material. The backfill material shall be tamped with mechanical tamping

equipment, after moistening the backfill by sprinkling with water to obtain maximum compaction (min 95% proctor density).

Machine backfill shall be so conducted that the material deposited in the trench shall not fall directly on top of the pipe from such a height as might result in damage to the pipe joints or alignment.

If the trench is subjected to conditions which might cause flotation of the pipe before sufficient backfill has been placed, the Contractor shall take the necessary precautions to prevent floatation of the pipe, conduit or structure.

Before final acceptance of the work, additional tamped earth shall be added to restore the settled trench surface to the required level of the adjacent earth surface or to the base of crushed rock wearing surface or to the finished earth base.

If from the excavated soil, enough backfill material is not available, imported, selected and approved backfill material from the borrow pits is required to be placed for backfill, on approval of the Engineer backfilling of trenches where the excavation is in the rock shall be with the surplus soft soil, with all lead and lift.

3. DISPOSAL OF SURPLUS EXCAVATED MATERIAL

The excavated material which is in surplus to the requirements after backfilling shall be removed and spread at places shown by the Engineer, with all lead and lift from the site of work, for which no extra payment shall be made. No surplus or excess material shall be disposed in a stream / channel or in any place where the pre-construction surface drainage may have to be provided, without written permission of the Engineer.

IV) ANCILLARY STRUCTURES

1.1 Structures for Crossing Canal/ Nallahs and Other Miscellaneous Structures

Structures for crossing the pipeline over canals/Nallahs and other miscellaneous structures not listed in these specifications but may be required to be built shall be as per construction drawings and as described in Bill of quantities. The materials of construction of workmanship for those structures shall conform to the relevant Standard Specifications for Procurement of Project Works as given in Chapter 10. The measurement of quantities involved in these structures for payment shall be done as per dimensions of the respective drawings.

1.2 PIPE LINE CONNECTIONS

The Contractor is responsible for giving suitable connections at the inlet and outlet ends of the pipelines, etc.

V) Grade of concrete

1. Ordinary Concrete

In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and coarse aggregates are specified by volume. The ordinary concrete shall be in four grades designated as M 7.5, M 10, M 15 and M 20. It can also be specified

by volumetric mix as given in Table-4 below. For cement which normally comes in bags and is used by weight, volume shall be worked out taking 50 kg of cement as 0.035 cubic meters in volume. Shaking, ramming or hammering shall not be done. Proportioning of sand shall be as per its dry volume and in case it is damp, allowance for 'bulkage' shall be made as per IS: 2386 (Part III).

Ingredients required for ordinary concrete containing one bag of cement for different proportions of mix shall be as given in Table-4 below.

Table-4

Ingredients Required for Ordinary Concrete

Grade of Concrete *	Nominal Mix by volume Cement: Fine Aggregate: Coarse Aggregate**	Total quantity of dry in kg (max) by mass per 50 kg of cement (to be taken as the individual masses of fine and coarse aggregates)	Quantity of water in liters (max) per 50 kg of cement***
M 7.5	1:4:8	625	45
M 10	1:3:6	480	34
M 15	1:2:4	350	32
M 20	1:1.5:3	250	30

* In the designation of a concrete mix, letter 'M' refers to the mix and the number refers to the specified 28 days' works compressive strength of that mix on 150 mm cubes, expressed in N/ sq. mm.

** The proportions of the aggregate shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger.

*** The amount of water should be kept minimum required for proper workability. The quantity given in the column is not to be exceeded.

1.1 Strength Requirement of Concrete

Where Ordinary Portland Cement conforming to IS.269 or Portland Blast Furnace Cement conforming to IS:455 is used, the compressive strength requirements for various grades of concrete controlled as well as ordinary shall be as given in Table-5. Where rapid hardening Portland cement is used, the 28 days compressive strength requirements specified in Table-5 shall be met at 7 days.

For controlled concrete, the mix shall be so designed as to attain in preliminary tests a strength at least 33 per cent higher than that required on work tests for concrete up to and including M 25, and 25 per cent higher for higher grades. Preliminary tests need not be made in case of 'ordinary concrete'.

Table-5 : Strength Requirements

Grade of Concrete	**Compressive test Strength on 150 mm cubes after testing in accordance with IS: 516 (N/sq.mm)**	
	Minimum at 7 days	**Minimum at 28 days**
M 10	7	10

M 15	10	15
M 20	13.5	20
M 25	17	25

In all cases, the 28 days compressive strength specified in Table-5 shall alone be the criterion for acceptance or rejection of the concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in Table-5, such concrete shall be classified for all purposes as a concrete belonging to the lower of the two grades between which its strength lies.

VI) TESTING AND COMMISIONING

1. Testing at site

All sewers and appurtenances shall be tested before commissioning and trial run as per the specifications this section. After laying and jointing of sewer pipes and before backfilling the trenches, the complete length of the sewer is to be checked for water tightness and the sole responsibility of arranging the necessary equipments and apparatus lies with the operator at his own cost. Any damage during testing shall be rectified by him free of cost. Water for testing shall be arranged by the operator at his own cost.

1.1. Water Test For Sewers

After Laying and jointing of sewer pipes and before back filling the trenches, the complete length of the sewer is to be checked for water tightness, Owner may exempt water test for lateral sewers, where house service connections are to be connected immediately.

The procedure for testing is as detailed as below,

1. Each section of sewer shall be tested for water tightness from Machine hole to Machine hole to prevent change in alignment and prevent disturbance after the pipe have been laid, it is desirable to back fill the pipes upto the top keeping at least 90cm length of the pipe open at the joints in case of longer length pipes.
2. In case of concrete and stone ware pipes with cement moratar joints, pipes shall be tested three days after cement mortar joints have been made. It is necessary that the pipelines are filled with water for about a week before commencing the application of pressure to allow for the absorption by pipe wall.
3. The sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock. The water is filled through a funnel connected at the lower end provided with a plug. After the air has been expelled through the air outlet, the stop cock is closed and the water level in the funnel is closed to 2.50m above the invert at the upper end. Water level In the funnel is noted after 30min and quantity of water required to restore the original water level in the funnel is determined. The pipeline under pressure is then inspected while the funnel is still in position . there shall not be any leaks in the pipe or joints (small sweating on the pipe

surface is permitted). Any sewer or part there of that does not meet the test shall be emptied and repaired or re-laid as required and tested again.

4. The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10min shall not exceed 0.2 lit/mm dia. Of pipe per kilometer length per day.
5. Ex filtration test for detection of leakage shall be carried out at a time when the ground water table is low.
6. For concrete , RCC pipes of more than 600mm dia the quantity of water inflow can be increased by 10% for each additional 100mm of pipe dia.
7. After Complete on of the test all temporary seals shall be removed, the test water shall be drained out/pumped out and the line cleaned properly.

1.2. Test for straightness and obstruction

As soon as stretch of sewer is laid and tested, before commissioning the cleanliness of the pipeline is to be checked by the following tests as applicable and as decided by the engineer.

1.3. Torch and Mirror test

In this method of testing , a torch will be held in one end of the pipeline inside a Machine hole and its image through the pipeline will be reflected and seen on a mirror held at the opposite end of the pipeline, inside the next Machine hole. Any obstruction/debris/ major mis-allignment will not give a clear image in which case the pipeline will again be cleaned/ rectified and tests re done.

1.4 Ring Test

In this method testing of two steel/wooden rings of suitable thickness and design shall be fixed facing each other at a distance pf 2feet or more. The blocks of rings shall be inserted from o end of the pipeline, inside Machine hole and pulled by rope fixed to the block from the other end of the pipeline, inside the next Machine hole. The rings shall be dia 75mm less than the inside diameter of the pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by suitable means. Any construction/debris/major misalignment will prevent the ring to pass through the pipeline in which case the pipeline will again be cleaned/rectified and the test re done and no extra payment will be made. Alternately upon the approval of the Engineer the sewer may be tested by inserting at the high end of the sewer a smooth ball of dia 13mm less than the pipe bore, in the absence of obstruction such as yarn or mortor projecting through the joints, the ball should roll down the invert of the pipe and emerge at the lower end. . Any construction/debris/major misalignment will prevent the ring to pass through the pipeline in which case the pipeline will again be cleaned/rectified and the test re done and no extra payment will be made.

1.5 Water Test for Machine holes

The entire height of Brick and RCC Machine hole shall be tested for water tightness by closing the both incoming and outgoing ends of the sewer and filling the Machine hole with water. A drop in water level not more than 50mm

per 24 hours shall be permitted . in case of high subsoil water it should be ensured that there is no leakage of ground water into the Machine hole by observing the Machine hole for 24 hours after emptying it.

1.6 Test Records

Complete test records shall be maintained for all tests carried out for both sewer both during construction and after being service. The tests carried out as in specifications, approved QAP shall be documented in the formats as approved by the Engineer and shall be carried out in the presence of the Engineer or his representative and shall be certified by the engineer or his representative and the operator. All completed test record/documents shall be submitted to the Engineer before submission of bills.

1.7 Commissioning

After satisfactory completion of works and testing of the sewer lines and appurtenances as per specifications in above clauses, the system shall be commissioned for trail run and operation.

Jacking Ring and Frame

(a) The Contractor shall be required to use a jacking ring. The jacking ring may be either of steel or concrete construction and shall be used at all times when a pipe is being jacked. This jacking ring will allow the jacking pressure to be distributed evenly around the wall of the pipe.

(b) The Contractor shall also be required to use a jacking frame during all operations. The jacking frame shall be designed to distribute the stresses from the jacks evenly to the jacking ring.

Jacking Operations

(a) The Contractor shall be fully responsible for the materials, equipment and facilities required in conjunction with jacking the concrete pipe.

(b) Before starting work, the Contractor shall submit to the Engineers incharge for approval, a detailed schedule of the entire jacking operation. Approval of such schedule shall not relieve the Contractor of his responsibility to provide a fully satisfactory installation. The Contractor shall be required to include with his submission evidence that he has successfully completed a jacking installation using procedures similar to those proposed.

(c) Where chemical stabilization of soil is used, a chemical grout shall be pressure injected into the soil over and ahead of the pipe jacking to stabilise the soil. The chemical grout used shall have a demonstrated history of success for stabilizing soils similar to that through which the pipe is to be jacked.

(d) Where a mechanical shield is used, the Contractor must provide proof that the particular model of shield has been used successfully in soils similar to that on the site. The crew for the operation of the shield must

be specialist, with experience in the use of that particular type of machine.

(e) After the jacking operations has begun, the Contractor may have to work continuously (24 hours per day) if required and directed by the Engineers incharge until the complete length of jacked pipe is installed.

(d) The pipes shall be jacked into place, true to line and level. The maximum tolerance allowable in the displacement of the centreline of the laid pipe from the design centreline is 50 mm in the horizontal plane and 15 mm in the vertical plane but there shall be no back fall at any point. Any pipe which is not laid in its correct position must be removed and re laid or adjusted to obtain its correct position.

(e) For precast reinforced concrete pipes, there shall be provision to prevent the relative movement between pipes at the joints by the use of steel gaiters or other approved methods during jacking operation. A packing piece of compressible material shall be provided at each joint and shall be securely held before the pipes are lowered into the thrust pit. Details of proposals shall be submitted to the Engineers incharge for approval.

(f) The Contractor shall be required to furnish and install and remove to the extent required, thrust blocks or whatever provisions that may be required for backing up the jacks employed in driving the pipe forward. The jacking pit shall also be equipped with steel rails or beams embedded in concrete. These rails or beams will be used for placement and alignment of each pipe during the jacking operation.

(g) The Contractor shall be fully responsible for the design and construction of the jacking and receiving pits, thrusting wall, installation of jacking equipment, sheeting, bracing etc. and for the efficient execution of the jacking operation. Full details of the proposals, including plant, shield machine, equipment, operating procedures, jacking pit and intermediate jacking stations etc, shall be submitted to the Engineers incharge and shall be fully satisfactory to him before construction work begins. However, review of the plans shall not relieve the Contractor from his responsibility to provide a safe and satisfactory jacking pit.

(h) The Contractor shall be required to monitor closely the progress of the jacking operation. Daily site records of thrusting pressures and the line and level measurements shall be properly maintained and shall be available to the Engineers incharge at all times.

(i) It is the responsibility of the Contractor to ensure that the complete "tunnels" are watertight. If leakage occurs before completion or during the maintenance period, the Contractor shall carry out any remedial work that may be necessary to make the Works watertight all at his own expense. Contractor shall carry out the hydraulic testing as per IS 458 (Latest Revision).

(j) Contractor shall follow all safe working practices according to IS-4756 (Latest Revision) and BS-6164 (Latest Revision).

Cement Grouting

(a) The Contractor shall be fully responsible for preventing the occurrence of voids outside the pipe and if they occur he shall fill them with cement grout.

(b) Immediately following the jacking operation, the Contractor shall pressure grout the jacked section to fill all voids existing outside the pipe.

(c) (c) Systems of standard pipe, fittings, hose, and special grouting outlets embedded in the pipe walls shall be provided by the Contractor. Care shall be taken to ensure that all parts of the system are maintained free from dirt. Grout composed of cement, sand and other approved compound and water shall be forced under pressure into the grouting connections at the invert and shall proceed until grout begins to flow from upper connections. Connections shall then be made to these holes and the operation continued to completion.

(d) Apparatus for mixing and placing grout shall be of a type approved by the Engineers incharge. It shall be capable of mixing effectively and stirring the grout and then forcing it into the grout connections in a continuous uninterrupted flow.

(e) After grouting is completed, pressure shall be maintained by means of stop cocks, or other suitable devices until the grout has set sufficiently. After the grout is set, grout holes shall be completely filled with dense concrete and finished neatly without evidence of voids or projections.

1.1 Methods of Construction - Break-Outs from Shafts and Tunnels

(a) For the junctions of tunnels and shafts the Contractor shall submit, for the Engineer In charge's agreement a method statement describing the details of the work, with drawings and calculations.

(b) Tunnel and shaft linings shall not be broken out until all necessary temporary works, including ground treatment, where appropriate, have been completed to ensure the structural and geotechnical stability of the works.

(c)Temporary supports shall not be removed until so agreed by the Engineer in charge and the work for which they are required has been completed and the structure is capable of carrying the imposed loads. Once junction work is commenced it shall be completed as expeditiously as practicable.

(d) The break-out shall be of sufficient dimensions to accommodate the permanent structure to be built. Working space shall be kept to the minimum dimensions practicable.

(f) The break-up for a tunnel shall enable the construction of a stable initial length of an adequate tunnel lining, built within the specified construction tolerances.

(g) Ground improvement or other acceptable means shall be provided at shaft break-outs and break-ins as required to prevent instability of the

ground as the sewer excavation exits or enters a shaft and elsewhere as required.

(h) The Contractor is deemed to have included in their price the cost of the interface with other contract including any ground improvement required to allow the access to the shaft or for the pipe jacking machine to be recovered as part of the works. The contract interface works are deemed to include shaft break-in or shaft breakout.

1.2 Limits of Surface Settlement

The method of jacking adopted by the Contractor shall be such that the initial surface settlement measured directly above the front face of the shield during the jacking operations do not exceed 25 mm and the maximum surface settlement after the tail voids are grouted shall not exceed 50 mm. Subsequently, the ground shall be reinstated to the original level not with standing, for the sections of pipeline near to sensitive structures, crossing under all roads along the route of the pipeline and paved area, the Contractor shall be required to incorporate in his jacking method measures to arrest the expected settlements so as to safeguard the integrity of the structures and road surfaces at all times. The Contractor shall ensure that the operational functions of these sensitive structures and traffic flows along all roads are not affected in any way by his work.

1.3 Shafts

Shafts - General

a) The working shaft shall be used for the construction of a manhole/chamber. The Contractor to construct the Jacking & Receiving pit as a permanent structural in RCC which would be served as a manhole during operation. The Jacking pit/Receiving pit would be converted into the manholes with necessary modifications including construction of the top slab, manhole cover frame, pipe benching, CI rungs etc. The Contractor to prepare the design & drawings as per the permanent structure requirements & shall be got it approved from the engineer.

(b) The Contractor shall submit for approval to the Engineers in charge dimensioned drawings and calculations of the timbering or trench sheeting details for the working shafts. Each working shaft shall have a separate ladder bay for access, which shall be isolated from the part of the shaft used for hoisting materials.

(c) Prior to excavation, the shaft area shall be thoroughly checked for existing utilities and the appropriate measures taken in agreement with the Engineers incharge.

Shafts - Safety

(a) Shafts shall be provided with guard rails or rings at least 1.2 m above the surrounding ground level.

(b) Once sunk to final level, the shafts for regular personnel access shall be equipped with ladders and landings at intervals not exceeding 6 m. Protection shall be so provided that neither ladders, supporting structures, nor persons using them are subject to risk of accident, from the passage of skips, spoil or materials. All ladders are to be secured at the top and bottom.

(c) Should heavy plant and heavy loads have to be located in close proximity to any shaft, the Contractor shall take into account the effects of these loads as well as any ground loads when designing the shaft.

(d) The Contractor shall guard against distortion of shaft lining during construction and the possibility of shaft settlement or uplift at an intermediate stage of construction.

Temporary Shafts

(a) Full details of temporary shafts required by the Contractor's shafts working methods shall be submitted to the Engineers incharge for his agreement. Such shafts shall be adequately sized for all operations required for the execution of the works.

(b) Backfill for temporary working shafts shall comprise material agreed by the Engineers in charge.

(c) Where the Contractor wishes to recover temporary shaft linings the structure shall be removed in safe stages as backfilling proceeds, taking care to maintain the safety and structural integrity of the remaining lining. No part of temporary works shall be left in the ground within 2 m of the designed final surface level.

Shafts - Construction

(a) Shaft sinking shall be carried out by a method suitable for all the particular circumstances of the site including ground parameters, groundwater, depth and final purpose.

(b) Where work is done by underpinning, only that ground which may be safely excavated for the installation of one ring or one unit of support shall be carried out. Until that depth is properly secured by permanent or temporary shaft lining, no further excavation shall take place. In the case of pre-formed rings securing shall include grouting.

(c) Where work is done by a caisson operation, a cutting edge shall be fitted to the leading ring. The cutting edge shall be maintained at an even level all round during shaft sinking. Jacking arrangements or kentledge shall be adequate for the work. The Contractor's arrangements shall

ensure the stability of any kentledge. A lubrication space shall be maintained around the full shaft periphery during sinking.

(d) Concrete walls installed by slurry trench or secant piling techniques shall comply with best
practice. The Contractor's proposals shall be submitted to the S.O. for his agreement.

(e) Where low pressure compressed air is used to assist shaft construction, air decks and locks shall be designed by the Contractor to give adequate margins of safety against the air pressures to be used in the shaft. The Contractor's proposals shall be submitted to the Engineers in charge for his agreement.

(f) Full details of temporary works required by the Contractor's method of working for the construction of tunnel or pipe jack eyes in the shaft lining, shall be submitted to the Engineers in charge for his agreement.

(i) Shaft bases shall be concreted. The Contractor shall submit his proposals for the shaft base structure taking account of ground and groundwater forces and sealing the shaft against water entry.

1.4 Mild Steel Pipe Work (Jacking Pipe)

Spiral welded pipes manufactured from HR coils conforming to IS 10748 Grade 3 steel. Plate welded pipes manufactured from plates conforming to IS 2062 Grade B steel.

I. Manufacture of Pipes

- **General**

Steel pipe shall be either plate welded or spiral welded pipe.

The pipes shall be truly cylindrical, and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacent to flange adapter with fixed outer diameter shall not deviate from theoretical one by more than 2 mm.

Any pipe or part thereof which develops injurious defects in the opinion of Engineer shall be rejected and shall be replaced by new pipe at Contractor's expense.

II. Plate Welded Pipes

All pipes and specials shall be manufactured out of mild steel plates conforming to IS 2062 Grade B steel. The procedure of cutting plates to size, rolling of plates, post bending, tack welding, internal and external welding, facing should be such that it results in pipes of required diameter and thickness conforming to IS 3589, or equivalent or better international standards.

III. Spiral Welded Pipes

All spiral welded pipes shall be manufactured as per IS 5504. The requirements for weldable hot-rolled carbon steel strip in coils should conform to IS 10748 Grade 3. The process of manufacture should be such that it results in pipes conforming to IS 3589/IS 5504 or equivalent international standards.

Demonstration

Contractor shall make necessary arrangements to demonstrate at the pipe manufacturing mill individual items of work before commencement of works and during the works at intervals specified and as directed by the Engineer. No payment shall be made in this regard.

The works under demonstration shall include

(i) Manufacture of pipe and specials
(ii) Chemical and mechanical testing of pipes and specials
(iii) Machine and manual welding to qualify 'Welding Procedures'
(iv) External coating
(v) Cement mortar lining
(vi) Hydraulic testing after cement mortar lining at 12 bar pressure

Tolerances

Tolerances for pipes shall be in accordance with IS: 3589 except for the following.

Negative tolerance on pipe wall thickness is not permissible.

The permissible tolerances for specials for diameter, arm length and angular deviation shall be in

accordance with IS 7322/BS 534

Welding

Upon receipt of the order and prior to the start of works, the Contractor shall submit to the Engineer for his approval the 'Welding Procedure Method Statement' he intends to use for the field welding.

All components of pipe shell; either straight or bent etc. shall be welded by use of automatic arc welding machine by submerged arc process with alternating current. The strength of the joint shall be at least equal to that of the parent material. Manual welding shall be adopted only when machine welding is not possible.

The Contractor shall use electrodes of approved make and size, the size depending on the thickness of plate and the type of joint. Standard current and arc voltage required for the machine shall be used with necessary modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer for qualifying the Welding Procedure Method Statement. Only approved welding procedures shall be used throughout the work and if any modifications are to be made, the written permission of the Engineer shall be obtained.

All the shop and field welding shall conform to IS 4353, IS 9595 and IS 816.

All longitudinal / spiral and circumferential joints shall be Single-V or Double-V butt joints with or without backing plates. After completing the welding joints of pipes or plates from one side, and before the welding on the other side, the joints shall be back chipped/ gouged and ground to remove irregular penetration till the even surface is exposed. Gouging shall be resorted to when the plate thickness is above 6 mm.

All circumferential welds involving plates of unequal thickness shall be so kept that the inside surface of plates match to provide stream lined joints without alteration in the internal diameter.

The welding shall be of the best workmanship free from weld defects. In order to maintain a good standard in welding, welders shall be tested by the Contractor before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operators shall conform to IS: 7307 and IS: 7310 (latest). Only those who pass the test shall be allowed to work on the job. Periodical tests as regards their competence shall also be taken at suitable intervals and those found incompetent shall be removed from the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully checked by X-ray in addition to the regular X-ray inspections. The defects if any shall be rectified to the satisfaction of the Engineer. All such check tests and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory and qualified. Site welds shall be done by welders qualified for the various welding positions as per applicable IS codes and standards.

A record shall be maintained showing the names of welders and operators who have worked in each individual joint. Manual arc welding shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorised person shall be permitted to do any welding whatsoever.

The weldment should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment shall match with the base metal properties including original ductility. The weld should in no point be less than the nominal thickness of plate. A slight reinforcement as per IS codes shall be maintained on all weld joints. Final welding of closure gaps should be carried out within a temperature range of average air temperature 8^{o} C.

- **Radiograph of welded joints**

Soon after welding, each longitudinal / spiral and circumferential welded length, the minimum length of the weld at random for each pipe shall be radiographed to detect welding defects, as per the requirements of IS 4853 and as directed by Engineer. This sampling will be at random to ensure 100% coverage of junctions of longitudinal / spiral and circumferential joints. If the results of such radiography fail to conform to the requirements, the Contractor shall carry out at his expense 100 % radiography test for the pertinent pipe as directed and fully satisfying the Engineer.

The percentage breakdown of radiography is as follows:

Pipes and Specials manufactured at Mill / Factory - 10%

Field joints welded at site - 5%

The weld ripples or weld surface irregularities and slag etc., on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment.

The radiographs are to be marked in such a way that the corresponding portion of the welded seam and the welder can be readily identified. All radiographs will be reviewed by the Engineer to identify the defects and determine those which requires rectification. Defects that are not acceptable shall be removed by chipping, grinding or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Engineer based on the latest standards prescribed by relevant Indian Standard specification.

All X-rays shall be taken with equipment and by personnel of the Contractor. Films shall be developed within 24 hours of exposure and be readily accessible at all times for inspection by the Engineer. The Contractor shall provide for the use of the Engineer suitable X-ray viewing equipment. X-ray films shall be properly maintained by the Contractor. A complete set of radiographs and records as described in IS: 2595, for each job shall be retained by the Contractor. All films shall be identified by the number and chart prepared indicating location of any work associated with the pipe erection and such inspection shall be performed by the Radiographer at the discretion of the Engineer.

Hydraulic Pressure Test at Pipe Manufacturing Mill

A hydraulic test shall be carried out at the mill for each pipe length fabricated. All pipes and specials shall be subjected to hydraulic test after fabrication, but before application of protective coatings and linings.

Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as slag, porosity etc. shall be repaired by gouging and re-welding.

Each pipe shall be filled with water slowly and the pressure increased uniformly until the required test pressure is reached. The test pressure shall be as follows:

MS pipes and fittings – 12 bars.

The pipe to be tested shall be given a serial number which shall be painted with details such as pipe number, shell thickness, diameter, length etc. It shall be entered in the register to be maintained by the Contractor. The register shall be maintained in suitable format giving the following information for each shell tested:

a) Serial No.
b) Pipe No.

c) Date of test
d) Specification, diameter and wall thickness
e) Weight of pipe shell tested
f) Maximum test pressure
g) Details of test performance
h) Name of Engineer’s representative witnessing tests

A copy of these details shall be furnished to the Engineer

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

The pressures shall be applied gradually by approved means and shall be maintained for at least 10 minutes or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer.

The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding done after dewatering the pipe. The repaired pipe shall be re-tested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected. The Engineer shall be supplied with two copies of the results of all the tests carried out.

No pipe shall be transported from the mill to the site and laid unless they have been hydraulically tested.

Tests and Inspection

The Contractor should submit results of inspection and testing covering the following in a suitable proforma, at the time of delivery of pipes in accordance with IS 3589/IS 5504. In case of discrepancy between the requirements of the above standards the more stringent conditions shall apply. Each pipe shall be subjected to mechanical and hydraulic tests as per IS 3589 and the corresponding test certificates shall be furnished along with. The test specimen shall exhibit mechanical and chemical properties not lower than those specified for IS 2062 Grade B/IS 10748 Grade 3 steel. The tests should also include determination of yield strength, tensile strength, elongation and bend tests. Tensile tests shall be carried out in accordance with IS 1894 on a test specimen provided from each lot of 100 lengths of pipe. Guided bend tests shall be carried out in accordance with IS 3589/IS 3600. One bend test shall be carried out from each lot of 50 lengths. The tests shall comply with the requirements specified in IS 3589/IS 3600.

The Contractor shall submit the following:

- pipe manufacturing process

- grade of pipe

- chemical composition – product analysis

- jointers

- tensile test report

- flattening test report
- weld test reports

- hydrostatic test report

- bend test report

- radiography report

- weld test report

The Contractor should notify the Engineer, in advance of the procurement of materials and fabrication in order that the Employer may arrange for mill and shop inspection (including third party inspection). The cost of tests including third party inspection shall be at Contractor's expense. The Engineer in his opinion may reject any or all materials or work that does not meet with any of the requirements of this specification. The Contractor shall rectify or replace such rejected material/performed work at his own cost to the satisfaction of the Engineer. The Engineer has the right to have the material tested independently to confirm the quality of the works.

The Contractor shall supply free of cost required specimen of materials for testing by the Engineer at any time during the progress of work and shall bear the cost of such tests or retests to the satisfaction of Engineer.

No separate payment will be made for any of the inspection and tests mentioned above and the rates for the items concerned shall be deemed to have been included in Contractor's item rates.

Mechanical Tests

The test plates shall be subjected to all mechanical tests as per the approved Method Statement, or as otherwise reasonably directed by the Engineer. Tests shall be carried out in accordance with relevant standards. The tests shall include determination of yield strength, tensile strength, elongation and bend tests. Tensile tests shall be carried out in accordance with IS 1894. One test plate shall be provided for from each lot of 100 lengths

If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen submitted. The welded joint shall exhibit mechanical and chemical properties not lower than those specified for IS 2062 Grade B.

Guided Bend test shall be in accordance with IS 3589 /IS 3600. One bend test shall be carried out from each lot of 50 lengths. The test shall comply with the requirements specified in IS 3589/IS 3600.

The field welded joints shall be tested in accordance with the procedure laid down in IS 3600. One test plate shall be taken for every 10 joints and shall be subjected to mechanical and chemical tests as specified above.

Re-tests

If the results of tests of any lot do not conform to the requirements specified, retests of two additional specimens from the same lot shall be made, each of which shall conform to the required specifications. In case of a failure of one or both, gouging and repairing shall be carried out to the particular lot of joints from which the samples have been taken as directed by the Engineer before the lot can be accepted. The rectification process also shall have adequate test plates and they shall be tested for compliance with the IS codes/standards.

In case both the samples yield satisfactory results in the re-test described above, gouging and repairing will be required to be carried out on the joint which has failed in the initial test only.

All charges in connection with re-testing of the welded samples including machining, testing etc. shall be borne by the Contractor.

Marking

All pipes and specials shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending. The marking operation shall be conducted with full size rulers and templates with suitable paints.

The following information shall be clearly mentioned on each pipe and special.

Manufacturer’s name with his registered trademark

Pipe / special with its serial number

Process of manufacturer and type of steel

Outside diameter (mm)

Pipe wall thickness (mm)

Length of pipe / angle of bend (in degrees)

Date of manufacture of pipe and special

Test pressure

After the hydraulic tests on the specials the direction of flow shall be stamped in a prominent manner. **Transportation, Handling, Stacking and Inspection**

- **General**

All pipes and specials manufactured at the mill shall be transported to the site of laying after cleaning them internally, etc. Vehicles on which pipes are transported shall have a body of such length that the pipes do not overhang. Pipes should be secure during transit. To ensure that laying of pipes is not held up at any time, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug plates, manhole covers and short length of smaller diameter pipelines at site in his field stores in consultation with the Engineer. Whenever possible, the Contractor shall arrange one full month’s requirement of pipes, specials, etc. stacked suitably along the alignment. All gaskets, nuts

and bolts flange adaptors and other similar items shall be stored in dry conditions, raised off the ground in sheds or covered areas. Until required for incorporation each rubber ring or gasket shall be stored away from windows, electrical equipment and other materials like oil and chemicals and also from heat and cold. Where items require special storage requirements, the method of storage shall be to the approval of Engineer and in accordance with manufacturer's requirements. Storage areas shall be set out to facilitate unloading, loading and checking of materials. End covers and other protection shall not be removed until incorporation of the pipes or fittings into the Works. The Contractor shall provide 2 (two) sets of accurate 'Go" and 'No Go' ring gauges to measure the diameter of pipes, specials and fitting for the use of the Engineer at no extra cost.

- **Transportation and Handling**

The pipes and specials shall be handled in such a manner as not to distort their circularity or cause damage to their surface. Contractor shall provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of laying. The props shall be retained until the pipes are laid. Details of proposed propping (strutting) system shall be submitted to Engineer for approval and if required by the Engineer, the method of propping (strutting) shall be demonstrated and tested at site. Valves shall not be lifted by the spindle

Pipe handling equipment shall be maintained in good condition and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded. Under no circumstances shall pipes be dropped, be allowed to strike one another, be rolled freely or dragged along the ground. No defective/damaged pipe shall be used in the works without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

- **Stacking and Inspection**

The Contractor shall keep a responsible representative to take delivery of pipes, specials and appurtenances, etc., transported from the pipe manufacturing factory or a stock yard. Pipes and appurtenances should be handled, stored and stacked in a suitable manner as directed by Engineer. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Gaps must be left between stacked pipes to permit access from one side to the other. The pipes, specials and appurtenances received at site shall be inspected and defects such as protrusions, grooves, dents, notches, damage to the protected coating, etc., shall be pointed out to the Engineer at site and in acknowledgement challans. Such defects shall be rectified or repaired by the Contractor at his expense, to the satisfaction of the Engineer. It will be the responsibility of the Contractor to protect the pipes, specials and other items stacked along the alignment against any possible damages or theft.

External Coating

Unless otherwise specified or stated on the drawings the pipeline of diameter more than 1000 mm to be laid underground and the exposed pipeline supported on saddles shall be cement mortar coated

- **External Guniting**

Cement mortar coating shall be in accordance with IS 1916.

(i) Cement shall be Portland Cement in accordance with IS 8112
(ii) The cement content shall be 600 kg/m^3 and water : cement ratio by mass shall not exceed 0.3:1
(iii) A length of 15 cm at each end of the pipe shall be left ungunited to facilitate site welding. The end faces shall be vertical.

- **Mix Proportion**

Cement mortar shall consist of 3 parts sand to 1 part cement by volume. The water in the mixture shall be carefully controlled so as to attain the required strength and so that the mortar will not run, sag or segregate.

- **Thickness of coating**

The minimum thickness of the coating shall be 25 mm with a positive tolerance of 3 mm and no negative tolerance. Checking of the coating thickness shall be by non-destructive means such as ultrasonic thickness gauge.

- **Surface Preparation**

The surface of all pipes to be coated with cement mortar shall be thoroughly cleaned by hand or by sand steel grit blasting if necessary. After cleaning the external surface of pipe shall be given a coat of cement wash.

All oil and greases on the surface of the metal shall be removed thoroughly by flushing and wiping using suitable solvents and clean rags. The use of dirty or oily rags will not be permitted. All other foreign materials shall be moved by buffing or by scrapping and wire brushing. After cleaning, the pipe shall be protected and maintained free of all oil, grease and dirt that might fall upon from whatever source until the pipe has received its cement mortar coating.

If blasting is necessary, all metal surfaces shall be thoroughly blasted to bright metal. Blasted surface which acquire a coat of rust shall be cleaned/reblasted as directed by the Engineer

- **Reinforcement**

Reinforcement for the coating shall comprise of 50 x 50 x 3 mm wire mesh conforming to IS 1566 and 8 mm dia. bar to IS 1786. The mesh sheets shall overlap each other by a minimum of 100 mm and be tied with mild steel wire at 200 mm intervals. The reinforcement shall be held off the pipe wall by a series of 10 numbers equally spaced 8 mm dia reinforcement bars which shall

run the full length of the coating. Clear cover to the reinforcement shall be in accordance with IS 1916.

- **Application**

The pressure in the lower chamber of ‘Cement Gun’ shall be sufficient to produce a nozzle velocity of 115 to 150 m/sec when a tip with 19 mm opening is used. The compressor used shall be of an adequate capacity to maintain a pressure of at least 2.8 kg/cm^2 at the gun end. The nozzle shall be held at such a distance (65 to 100 cm) and position so that the stratum of flowing materials shall impinge as nearly as possible at right angles to the surface being gunited. All deposits of loose sand shall be removed prior to placing any layer of gunite. Gunite shall be shot in one coat to the specified thickness. Every precaution shall be taken to prevent the formation of sand pockets and if any develop, they shall be cut out and replaced with satisfactory machine placed material. No hand patching will be allowed. The Contractor shall apply the coating in such a manner that no sloughing shall occur at any time during or following its application.

Gunite shall be placed in the top and sides of the pipe, then screeded to a uniform thickness and the ground lines or blocks removed. All rebound and waste materials shall then be removed by air blowing and gunite placed in the bottom of the fittings and screeded. When completed, the coating shall be concentric with the barrel of an even thickness. The entire surface shall then receive a final flash coat of gunite and shall be steel towelled to a true surface equal in smoothness to the spun lining in such a manner not to impair the bond between mortar and steel plate. The guniting and surface finishing shall complete in set and shall be applied continuously without the use of construction joints. In case, for any reason whatsoever, the cement does not adhere to the walls of pipes and sloughs off, swabbing the pipe with cement slurry shall not be permitted.

If for any reason it is necessary to interrupt the placing of the gunite for a length of time that will result in the material taking a permanent set, a square shoulder shall be formed at the ends of the sections and/or elsewhere by shooting against a back or by working with a trowel or other suitable tools the irregular edges of the material last placed to a clean unbroken surface face perpendicular to the pipe that will provide a suitable connection or construction joint between such material and the material to be placed subsequently. When performing this work care shall be taken not to shatter or disturb the material remaining in place or disturb the embedded wire mesh. Before placing fresh material against the surface of such joints, they shall be carefully cleaned and wetted to ensure a good bond between the fresh material and that previously applied.

The ungunited portion at the ends of the pipe lengths left for the purpose of field welding shall be coated with M15 concrete by hand after the field welding and hydraulic testing are completed.

- **Curing**

After the mortar has set, but not later than twelve (12) hours after application of the coating, curing shall be commenced. Coating shall be kept continuously moist and in the shade for at least 14 days.

- **Inspection**

Pipe coatings shall be inspected prior to transports, to laying site and broken, defective or otherwise unsatisfactory areas may be rejected at any time during construction. All defective areas shall be made good to the satisfaction of the Engineer. Coating cracks over 0.25 mm wide or over 500 mm long shall be made good.

- **Tests**

Compressive strength test of concrete shall be conducted on 150 mm cubes in accordance with IS 516. The number of tests shall be at least 4 cubes for each age and each water cement ratio for each days work. The concrete mix shall have a minimum characteristic compressive strength of 25 N/mm^2 at 28 days.

- **Fiber Reinforced Coal Tar Enamel Coating**

Unless otherwise specified or stated on the drawings the pipeline of diameter 1000 mm and less to be laid underground and the exposed pipeline supported on saddles shall be externally coated with Fiber Reinforced Coal Tar Enamel at pipe manufacturing mill.**)**